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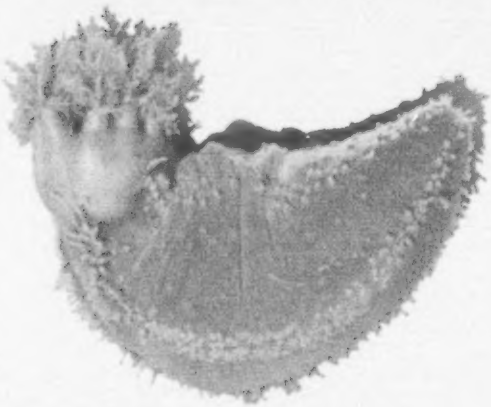
Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2014/054

ASSESSMENT OF THE SEA CUCUMBER FISHERY IN THE QUEBEC'S INSHORE WATERS IN 2013



Picture : Jean-Paul Dallaire, DFO

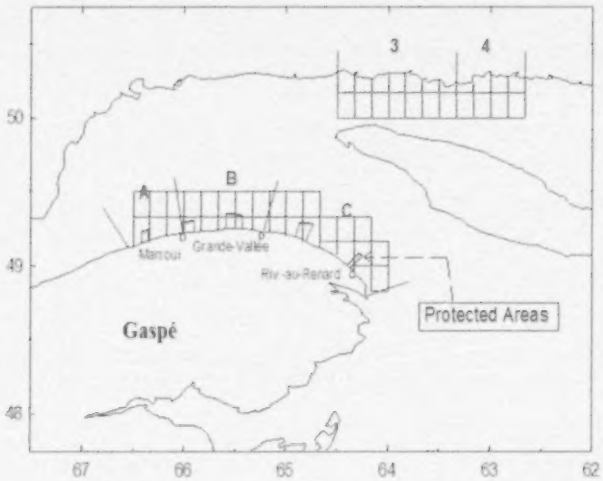


Figure 1. Sea cucumber management units (Units A, B, C, 3 and 4) in Quebec and protected areas.

Context:

*The sea cucumber (*Cucumaria frondosa*) fishery is a recent activity in the Estuary and northern Gulf of St. Lawrence. It began in 2008 on the Gaspé Peninsula's north shore and in 2009, on the Middle North Shore near Havre-Saint-Pierre. This fishery is carried out either by diving or by using an LGS-type dredge or a dredge specifically designed for sea cucumbers. Harvested cucumbers are processed in Quebec and in Maine, and products are exported mainly to Asian markets. There is currently no local market.*

In 2004, a study was conducted to determine the potential of this fishery on the Gaspé Peninsula. Following this study, initial exploratory licenses were issued in 2008 for Unit A, B, C and 3, as well as an experimental license for Unit 4 and for the Magdalen Islands.

The resource is assessed every three years to determine whether changes that have occurred in stock status require adjustments to the conservation approach and management plan. This assessment follows the one produced in 2011 for the sea cucumber in the Estuary and the northern Gulf of St. Lawrence.

October 2014

Canada

SUMMARY

- The sea cucumber fishery began in Quebec in 2008 and is still in the exploratory stage. Total landings were 1489 t in 2013, with 87% coming from the Gaspé Peninsula's north shore (Units B and C) and 13% from the North Shore (Unit 3).

Zone B

- Landings have increased since 2009 and reached nearly 90% of the TAC of 600 tonnes in 2013.
- The CPUEs have increased since 2010, reaching their highest point in 2013. Maintaining high CPUE values is facilitated by the possibility to exploit new fishing sites.
- The mean commercial size of sea cucumbers measured at sea has remained stable since 2011.

Zone C

- Landings for the last two years (2012 and 2013) have reached nearly 92% of the TAC of 800 tonnes.
- Although the effort has increased significantly since the beginning of the fishery, the CPUE has also increased and is now at its highest value of the series.
- The mean commercial size at sea has remained stable since 2011 and is higher than that of Unit B.

Zone 3

- Landings and the number of days fished decreased by 42% and 36% respectively in 2013 compared with 2012. Last year, the number of days fished was well below the authorized effort, which is 70 days fished.
- The CPUE was slightly lower in 2013 than in previous years. Operational problems may be the cause of this decrease.
- The mean commercial size measured at sea or landed remained relatively high and even increased in 2013.
- From 2011 to 2013, the sum of the 9 main accidently captured species was 5 to 11% of the number of sea cucumbers, depending on the unit.

Recommendations

- For Units B, C and 3, the recommendation is to maintain current management measures for the next three years. These measures are a TAC of 600 t and 800 t in Units B and C respectively, a fishing effort of no more than 70 days in Unit 3, and a legal size of 116 mm in all units. This recommendation is in line with the approach of managing emerging fisheries in stages, where indicators must remain stable before fishing pressure is increased.

- In addition, recommendations include creating one or more refuge areas in Unit 3, maintaining monitoring of accidental captures in all three units, and continuing with the post-season survey started in 2013 in Units B and C.

BACKGROUND

Species Biology

The sea cucumber, *Cucumaria frondosa*, is an echinoderm founds in the north Atlantic and Arctic oceans. It is found in most habitats in the Estuary and the Gulf of St. Lawrence. In the south, its range extends to Cape Cod. The sea cucumber lives in depths of less than 10 m during its early years and later migrates very slowly to depths of up to 60 m. However, it can be found at depths of over 400 m. It has five rows of tube feet that allow it to move and to attach to substrates. It prefers complex rocky bottoms or mixed substrates of gravels, stones, sand and shells. The sea cucumber feeds on phytoplankton and zooplankton by spreading out its ten tentacles, which capture plankton suspended in the water column or organic matter sitting nearby on the substrate. The tentacles are covered with sticky mucus, which aids in harvesting. Each tentacle is retracted individually into the sea cucumber's mouth, where the plankton is then eaten. The species has very low mobility. Sea cucumbers gather in aggregations known as "beds"; this behaviour ensures a certain level of success in reproduction, which is achieved by external fertilization.

According to the data available for Quebec, sea cucumber spawning occurs in mid-June-later than that observed in the Bay of Fundy (April–May), Newfoundland (February–May) and Maine (March–April). The sea cucumber has separate sexes but does not exhibit sexual dimorphism. New larvae undergo an initial 48-hour pelagic phase, after which they settle, preferring the undersides and sides of gravel as well as rocks with crevices.

In Quebec, the size at which the cucumbers begin to reach sexual maturity would be between 80 and 102 mm, which is higher than in Newfoundland (Grant et al. 2006). According to another study done in Newfoundland (So et al. 2011), this species would require at least 25 years to reach a size of 150 mm, while in the Gulf of St. Lawrence, the maximum size is reached at an estimated minimum age of 10 years (Hamel and Mercier 1996).

Protecting at least one natural bed in each management unit is often recommended as a conservation measure for this species in order to ensure a certain reproductive success.

Fishery

Two different methods are used to harvest sea cucumbers. The first method, dive fishing, consists of diving underwater and removing the animals, either with or without the use of a siphon connected to a pump at the surface. This method is mandatory in Unit A and was used only in 2009. The second method, drag fishing, consists of towing a dredge behind a fishing boat. The dredges used in Quebec are lighter and more compact than the LGS (Light Green Sweep Urchin) drag type, which was developed in the United States for harvesting green sea urchins. In Quebec, sea cucumber dredges vary in width: 2.4 m in Unit 3, 3 m in Unit B and 3.7 m in Unit C. The height of the dredges varies from 0.25 to 0.5 m.

The first trial of sea cucumber fishing in Quebec was conducted in 2008 in Unit C, in the northern part of the Gaspé Peninsula (Figure 1). Catches for this trial totaled 201 t. The following year, the fishery was extended to Unit A (diving), to Unit B, adjacent to Unit C, and to Unit 3 in the Mingan region. A minimum size of 116 mm introduced in the first year on the North Shore, is now in effect in all Unit since 2013. In 2010, protected areas were established along

the Gaspé coast corresponding to about 15% of the licensed fishing territory (Figure 1). Fishing depths varied somewhat by unit: under 20 m in Unit A, 22 to 36 m in Units B and C and over 20 m in Unit 3. In 2013, a community commercial license has also been issued in Unit B and C. The fishery is still in the exploratory stages.

In Units A, B and C, fisheries are managed by TAC. These TACs are based on information obtained in the preliminary inventory, which was taken in 2004 (Campagna *et al.* 2005). In Unit 3, the fishery is managed by effort control, i.e. by limiting the number of fishing days each season. The limit is 70 days since 2010.

ASSESSMENT

The data on fishing effort and CPUE used in this assessment come from the harvesters' logbooks. The size structures and mean sizes of sea cucumbers were taken from the DFO landed commercial catch sampling program and from samples taken by at-sea observers. The fishing positions were obtained from logbooks.

Drag Fishery

The sea cucumber fishery began in Quebec in 2008 and is still in the exploratory stage. Total landings were 1489 t in 2013, with 87% coming from the Gaspé peninsula's north shore (Units B and C) and 13% from the North Shore (Unit 3) (Figure 2).

In Units B and C, commercial fishery landings almost reached the TAC for 2013. For Unit B, the TAC was set at 600 t (200 t in the spring and 400 t in the fall), and landings quadrupled from 2009 to 2013. The mean catch per unit effort (CPUE) had already been increasing since 2010, but it made a significant leap to 648 kg/hm (kilograms per hour/metre) in 2013 (Table 1). Fish harvesters still seem to be discovering new sites with good yields, which will likely allow the CPUE to be maintained at a high level. In Unit C, an initial and preventive TAC of 200 t for 2008 was subsequently increased to 800 t in 2009 (300 t in the spring and 500 t in the fall). The TAC was almost reached in 2012 and 2013. The effort in Unit C is generally higher than in the other units, and other than in 2013, the CPUEs are also the highest.

In Unit 3, the fishing effort limit of 70 days that has been in effect since 2010 was almost reached in 2010 and 2012. In 2013, according to the fish harvester, the use of a new boat was the reason for lower yield. Landings and the number of days fished decreased by 42% and 36% respectively compared with 2012. The CPUE has decreased slightly since 2010, and in 2013 it was below the historical average of 239 kg/hm.

Table 1. Total allowable catch (TAC in t), quota (day), effort (day) and catch per unit effort (CPUE in kg/hm) in the Quebec commercial sea cucumber drag fishery from 2008 to 2013.

Year	Unit B		Unit C		Unit 3		
	TAC (t)	CPUE (kg/hm)	TAC (t)	CPUE (kg/hm)	Quota (day)	Effort (day)	CPUE (kg/hm)
2008			200	392			
2009	200+400	296	300+500	433	35	23	234
2010	200+400	172	300+500	379	35+35	68	249
2011	200+400	276	300+500	381	35+35	64	241
2012	200+400	351	300+500	408	35+35	67	233
2013	200+400	648	300+500	507	70	43	205
Average		**349**		**417**		**53**	**232**

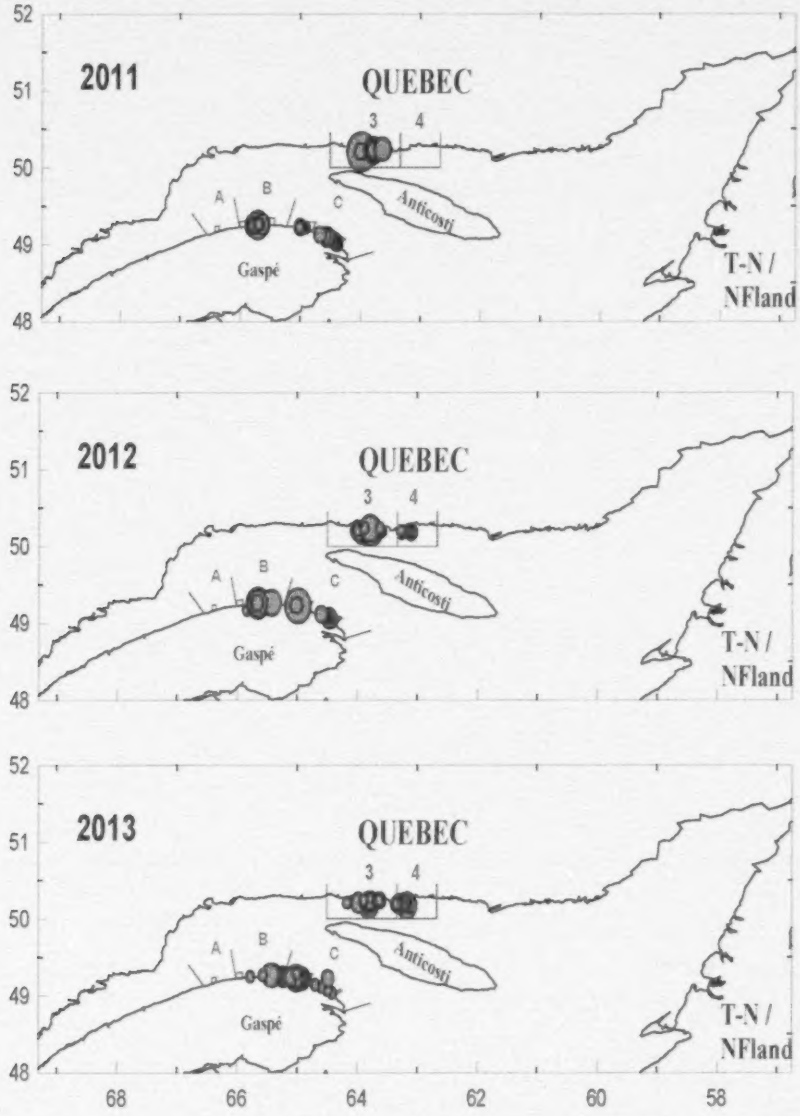


Figure 2. Sea cucumber fisheries in Quebec from 2011 to 2013. The size of the circles represents the relative fishing effort (number of trips made) in that position.

The size structures of sea cucumbers sampled at sea show maximum sizes of 240 or 260 mm depending on the unit (Figure 3), far from the maximum size of 350 mm observed for Quebec. The mean commercial size of individuals measured at sea has remained stable since 2011 in Units B and C. It seems to be increasing slightly in Unit 3, but data from the last two years come from dockside sampling and involve only a small number of individuals. The mean sizes observed in Unit B remain below those in the two other zones.

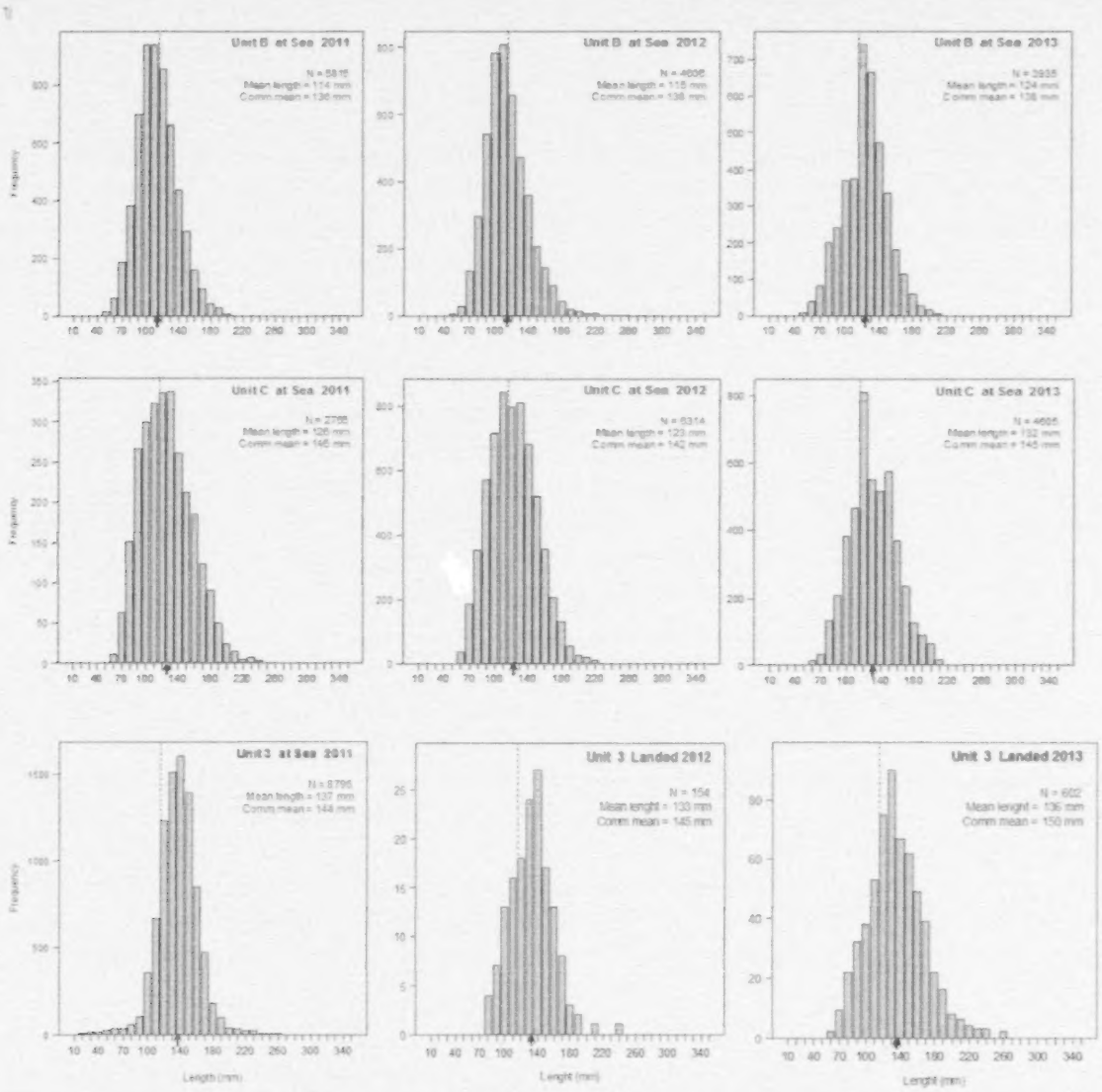

Unit B at Sea 2011
Unit B at Sea 2012
Unit B at Sea 2013
Unit C at Sea 2011
Unit C at Sea 2012
Unit C at Sea 2013
Unit 3 at Sea 2011
Unit 3 Landed 2012
Unit 3 Landed 2013
Frequency
Length (mm)

Figure 3. Size structure and number (n) of sea cucumbers measured at sea or landed from the drag fishing in Units B, C and 3 from 2011 to 2013). The vertical dotted line represents the minimum catch size of 116 mm. The mean size of all individuals (Mean size) and the mean size of 116 mm or more (Comm mean) are indicated. The arrow shows the mean size of all individuals harvested.

Bycatch species

From 2011 to 2013, the sum of the 9 main accidently captured species in Units B, C and 3 was 5 to 11% of the number of sea cucumbers harvested (Table 2). In zone 3, sampled only in 2011, the percentage of bycatch species was similar to the other two Units, but species composition differed. Green sea urchins were dominant in this unit while starfish was dominant in Units B and C.

Table 2. Number of sea cucumber and main bycatch species caught in each Unit during the sea cucumber fishery from 2011 to 2013 in Quebec. The percentage (%) of the last column represents the proportion of the nine major bycatch species harvested compared to the number of sea cucumbers.

			Main bycatch species									
Year	Unit	Cucumber	Urchin	Hyas	Rock Crab	Snow Crab	Soft coral	Scallop	Whelk	Anemone	Starfish	%
2011	3	34864	1801	131	30	0	0	8	33	0	294	7
	C	310634	0	3447	3071	3	0	205	3	0	7416	5
2012	B	254288	3977	5097	2908	4	115	1015	374	697	9728	9
	C	574490	566	7466	9258	19	27	488	117	1532	25860	8
2013	B	413966	784	4570	5600	0	0	799	33	1588	15162	7
	C	434479	1328	4317	9978	0	585	3093	754	1236	27489	11

Sources of Uncertainty

The sea cucumber fishery is currently done using fishing gears still in development and differing greatly from one sector to another. CPUE estimates between these sectors and annually could be influenced by these differences. In addition, fishing techniques favored by harvesters, such as dredging speed, cable length, towing direction relative to the current and the towing duration, may also have an influence. Furthermore, only a portion of the licensed area for fishing is currently operated by each harvester. Interannual variations are possible if they do not visit the same sites from one year to another.

The mean sizes of sea cucumber measured at sea or landed are directly influenced by the technique used by the sampler to ensure that all individuals are sufficiently contracted.

The conclusions of this advice also depend largely on the quality of the information obtained with logbooks completed by fishermen and purchases slips collected at the dock. Any omissions or errors will influence the parameters estimation of sea cucumber stocks.

CONCLUSION AND ADVICE

Drag Fishing

Drag fishing for sea cucumbers is still in the exploratory stages in Quebec; only the north shore of the Gaspé Peninsula and one part of the Mingan region are currently being fished. Since the fishery is so new, we lack sufficient knowledge at this time to be able to determine an acceptable exploitation rate. The TACs recommended for Units A, B and C could be reassessed in light of new knowledge. Effort control may be the most appropriate way to manage this type of fishery. For this and all other emerging fisheries, any increase in fishing effort must be achieved gradually and even then only if catches are at the maximum granted quota and if the stock status has been stable or improving for a number of years. Furthermore, the differences already observed between the units suggest that management regimes should be developed specifically for each locale.

The gear currently being used must be improved so as to minimize by-catches and damage to habitats. The short-, medium- and long-term impacts of this gear must still be determined.

Les engins actuellement utilisés devraient être améliorés de façon à minimiser les captures accessoires et leurs impacts sur l'habitat. Ces impacts à court, moyen et long termes restent à être évalués.

Recommendations

For Units B, C and 3, the recommendation is to maintain current management measures for the next three years. These measures are a TAC of 600 t and 800 t in Units B and C respectively, a fishing effort of no more than 70 days in Unit 3, and a legal size of 116 mm in all units. This recommendation is in line with the approach of managing emerging fisheries in stages, where indicators must remain stable before fishing pressure is increased.

In addition, recommendations include creating one or more refuge areas in Unit 3, maintaining monitoring of accidental captures in all three units, and continuing with the post-season survey started in 2013 in Units B and C.

OTHER CONSIDERATIONS

Commercial exploitation of most species of sea cucumber around the world is done by dive harvesting. Despite the rudimentary means at the disposal of these harvesters, a number of stocks have collapsed and show no signs of recovery, which suggests we should be cautious about exploiting *Cucumaria frondosa* in our waters. We have no information on the resilience of this species at this latitude compared to stocks in more temperate regions.

We must work to improve our knowledge, which is still lacking in many areas, notably by mapping sea cucumber beds; determining the spawning season in our waters, growth rates, and the size at sexual maturity; and establishing the impact of the fishing gear on other marine species.

The industry also actively participates in improving our knowledge. Work done by the Mi'kmaq Maliseet Aboriginal Fisheries Management Association (MMAFMA) in Units B and C aims to compare the yield at fished and unfished sites, obtain basic information on sea cucumbers (mean size, maximum size, depths, etc.) and potentially to work on improving drag fishing.

SOURCES OF INFORMATION

This Science Advisory Report is from the June 3, 2014 Assessment of the Sea Cucumber fishery in the Quebec's inshore waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Campagna, S., Lambert, J. and Archambault, P. 2005. Abondance et distribution du concombre de mer (*Cucumaria frondosa*) et prises accidentelles obtenues par dragage entre Matane et Cap-Gaspé (Québec) en 2004. Rapp. tech. can. sci. halieut. aquat. 2620 : ix + 61 p.

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Grant S.M., Squire, L. and Keats, C. 2006. Biological resource assessment of the Orange Footed Sea Cucumber (*Cucumaria frondosa*) occurring on the St. Pierre Bank. St. John's: Centre for Sustainable Aquatic Resources Fisheries and Marine Institute, Memorial University of Newfoundland, 75 pp.

Hamel, J.-F. and Mercier, A. 1996. Early development, settlement, growth, and spatial distribution of the sea cucumber *Cucumaria frondosa* (Echinodermata : Holothuroidea). Can. J. Fish. Aquat. Sci. 53: 253-271.

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